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NESTING CANADA GEESE ON THE UPPER SNAKE RIVER

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In the spring of 1947 the authors made a nesting survey of Canada geese (*Branta canadensis*) along a 40-mile stretch of the Snake River. The study was conducted in Jackson Hole, Wyoming, directly south of Yellowstone Park. Much of the soil of this intermontane valley is composed of glaciated gravel outwash, through which the Snake River channels have cut forming gravel bars and islands. These bars, strewn with piles of drift and scantily covered with willow and cottonwood saplings, offer unusually desirable nest sites for Canada geese. The area is about 6,500 feet above sea level in the *Picea-Abies* formation. The immediate riverbank vegetation includes a variety of flood plain types with willow-sedge, cottonwood, and climax stands of spruce and fir predominating; the upper slopes contain lodgepole pine, aspen, and sagebrush types.

The Snake River, which has its headwaters in Lewis and Heart Lakes in Yellowstone Park, enters the north end of Jackson Lake emerging at Moran through the gates of the Jackson Lake

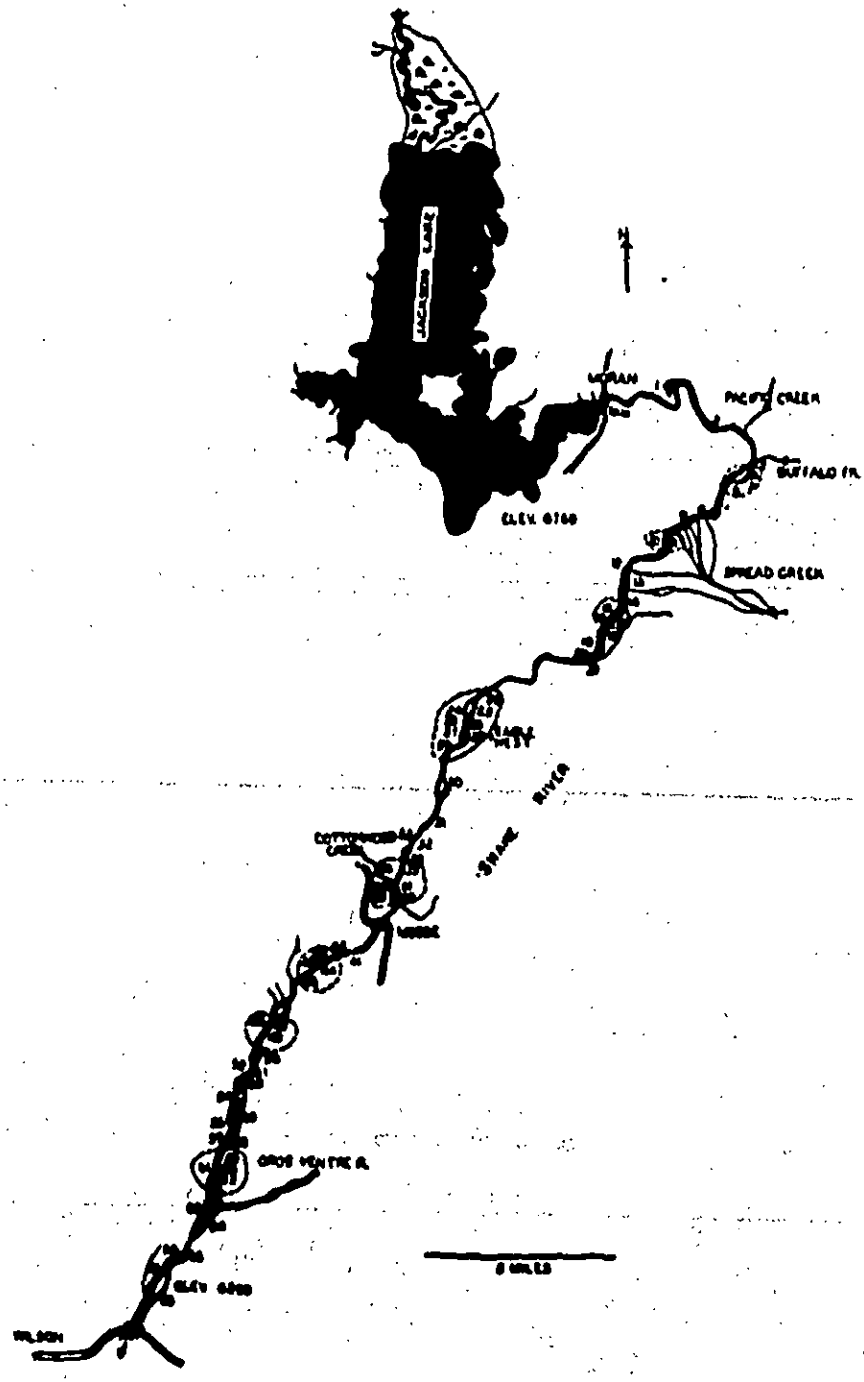

FIG. 1.—Map of Study area on Upper Snake River, Wyoming. Numbers from 1 to 68 indicate approximate locations of nests and nest sites. General nest sites are not included. Dotted lines surrounding numbers indicate groupings of nests.

Dam. The dam and reservoir are the property of the United States and are administered by the Bureau of Reclamation. The lake, with a capacity of 847,000 acre-feet, is a major storage reservoir in the Minidoka Project system. It supplies water for all project lands and in addition for about 750,000 acres of private land. The total irrigated area receiving water from this lake, in full or part, produced crops valued in 1917 at $87,600,000.

Jackson Lake Dam, which controls the water level of the river below, also has an important bearing on the nesting of Canada geese. In terms of cash value the geese are insignificant compared to the crop values dependent upon irrigation. General observations on the effect of fluctuating water levels on nesting Canada geese made in the spring of 1946 indicated that the birds fared poorly in this irrigation project.

A survey of geese nesting along the river was accordingly begun in 1947. The objectives being:

1. To determine the nesting population and gather data on the productivity of Canada geese on the upper reaches of the Snake River from Moran to Wilson. (See Figure 1.)
2. To determine the effect, if any, of the regulation of the water flow through the Reclamation Dam at Moran on the nesting of Canada geese.

Financial help for completing the study was obtained through the Jackson Hole Summer Research Program 1947 of the New York Zoological Society, and the Jackson Hole Wildlife Park.

A few facts on yearly activity of geese in this region may prove of interest. The Upper Snake River generally remains ice-free throughout the winter (even though temperatures drop to −40° F. and below). Geese remain along the river throughout the long winter period. In the spring the first observation of migration into the valley was March 13 when a flock of 21 geese was seen. For two successive years paired geese were observed defending nesting territories on April 1, although several feet of snow still covered the ground. By the middle of April geese were incubating; the height of hatching occurred close to the middle of May and was completed by the first of June. Successful parents remained on the river with their broods, while unsuccessful pairs continued defense and nesting behavior with diminishing intensity until about June 1. They then left the river or the lakes. By July 20, the goslings could fly. By August 10, geese were flying in high formations, but the authors believed that most of these were residents. By September 10, geese were congregating in large noisy flocks and the numbers indicated some migration of geese into the area from more northern regions.

STUDY METHODS

The methods used were selected as suitable for an extensive study of a nesting population scattered along 40 miles of a fast, powerful, relatively inaccessible river.

It was felt that a nesting survey could best be accomplished by floating down the river in a five-man rubber raft, taking three days to make each 40-mile trip. Approximately one-third of this distance was covered each day,

and frequent stops were made to locate nests of paired geese. Not all nests were found or even hunted for, but an effort was made to locate every nest site to get an accurate population of paired nesters or potential nesters. Nesting sites fell into three categories: *nests*, *nest sites*, and *general sites*. Geese that had nests or sites defended them; they did not fly until closely approached and usually walked off for some distance and honked their protests. If approached too closely they took off and usually circled and honked at the observer. When such behavior was observed a *nest* was recorded if in addition a nest hollow was found containing eggs or egg remains. A *nest site* was recorded where geese actively defended an area on two or more successive visits, and where shallow nesting hollows were found, but no eggs or egg remains. Such hollows sometimes eventually became the final nest, but some were false, early, or unsuccessful attempts. *General sites* were those defended on two or more successive visits, but where no actual nest or hollow was found. Many of the nests were well concealed, often completely covered with brush, sticks, and sometimes snow. Concealment of nests and limitation of time made it impossible to locate all nests even when they were known to be within a limited area. However, all pairs exhibiting nesting behavior at definite sites were readily located.

A number of associated observations helped to indicate not only the presence of a nest but its exact location; these were:

1. Paired or single birds defending territory and exhibiting nesting behavior.
2. A nearby gravel bar—preferably an island.
3. A raised hummock of vegetation or drift material on or near a gravel bar in proximity to the spot where geese were first seen.
4. An incubating bird, a tuft of down or feathers, or a matting of sticks and brush covering a possible elevated nest site.

While floating the river, relative abundance counts were made of the following birds: geese, ducks, sandhill cranes, pelicans, ravens, and hawks. For example, April 21 trip: ducks, 802; geese, 181; white pelicans, 96; hawks, 55; sandhill cranes, 4. The authors felt that the goose counts might be used for roughly estimating the nesting population if only flushed geese were counted and care was taken to avoid recounts.

WATER LEVELS

During the study, measurements of water levels were obtained at two stations, Moran and Moose. Bureau of Reclamation measurements were used for the former, 1.03 feet being the approximate minimum flow from the lake. Both the Moose and Moran low water marks were taken as constants from which to measure fluctuating levels. The water height at Moose when geese started nesting was 7 inches, at Moran 1.03 feet.

INITIAL LAYING

On April 12, nearly two weeks after the first observed territorial defense, fifteen miles of river were rafted to determine the status of paired geese. Over 50 were counted. The largest flocks, containing 11 and 13, indicated that

some geese had not yet started incubating. Quite a few pairs, however, exhibited nesting behavior and a nest containing 6 eggs was located. These eggs hatched on May 6. Allowing 26–28 days (Kossack, 1947; and Dow, 1943) for incubation and assuming six days for laying prior to incubation would place the initial egg laying on April 1–3. Comparing these goslings of known age with others, it was found that a few geese had started laying close to these same dates. The peak of laying and hatching occurred during relatively short periods—April 18–23, and May 16–21, respectively. Renesting attempts were observed but only two were known to have been successful. By April 24 the majority of geese had eggs, and the authors began the first of three complete trips down the river.

DISTRIBUTION OF NESTS

Nests were distributed along the entire stretch of river, although there was a tendency toward congregation in favorable sites—areas where the river spread over large expanses of gravel, formed numerous islands and channels, and piled drift and debris. Eight nests were located, along a one-mile stretch, six along another mile while four and three were not unusual. The average was about two nests per mile of river (Figure 1).

LOCATION OF NESTS

Nests were located on gravel bars and were situated on elevated clumps of drift or sod behind drift piles. Most sites furnished sufficient range and latitude of view that they could not be readily approached undetected. All locations had enough soil or finely broken drift material to enable the geese to scoop out a shallow saucer-like hollow. Nests in or near scanty clumps of willow and grass vegetation were just above normal summer water level but not above flood level. No nests were in dense cover.

Of 44 nests complete with eggs or in some stage of nest construction, or destruction, 42, or 95 per cent, were located on gravel bar islands varying in size from less than an acre to islands one-half mile long. Two nests were found on the river bank proper. One was in a large Douglas fir tree within an old red-tailed hawk nest approximately 80 feet above the water. Three such tree nests were known in the region and it is possible that periodic spring floods conditioned older birds to seek such sites.

NESTS IN RELATION TO WATER

The low water mark, or the level existing when geese started nesting, was used as a standard for measuring the height of goose nests above the water. The actual rise in water at any one place varied with the number of channels, their width and depth.

The average height of 43 nests (tree nest omitted) above the low water mark was 31.5 inches or roughly three feet. The highest nest was 76 inches above low water and the lowest 6 inches. The average distance of 44 nests from a river channel, small or large, was 43 feet, the maximum distance from water being 150 feet and the minimum 1 foot. Williams and Marshall (1937) found that 63 per cent and 77 per cent of 95 goose nests in the Bear River Marshes were 30 feet from channels and open water, respectively.

NEST LININGS

Twenty-seven of 44 goose nests were lined with down, 7 had eggs but no down. In some cases these nests had been flooded and the down washed away, but in others the geese had only an unlined nesting cavity. Ten cavities had neither eggs nor down and the lack of both was due to varied causes such as flooding in early stages of nest building, or incompleted nesting or renesting attempts. Several nests had a continuous sheet of down which formed a hinged door that could be pulled over the eggs.

AVERAGE CLUTCH

Due to the survey method of study, the data gathered on the size of egg clutches was not extensive. From 17 nests known to have had complete sets of eggs, the average number of eggs was 4.6 per nest. Williams and Marshall (1937) found an average of 4.8 eggs based on counts at 84 nests. Dow (1943) found an average of 5.09 and 5.10 eggs, respectively, from studies of 140 and 215 nests. Our brood counts, made soon after hatching, indicated that 5 eggs per nest would more nearly represent the average clutch than 4.6.

NESTING POPULATION

At the termination of the second trip, 88 nest sites with paired geese had been located and classified as follows:

Nests	44
Nest Sites	24
General Sites	20
Total	88

The two direct counts of geese made in two early trips down the river were approximately the same, 181 and 188. Any one count, divided by two to give pairs, approximated the total number of nest sites recorded. These counts would indicate a population of between 90 and 94 pairs of geese as compared to 88 pairs of geese actually defending nests or nest sites. For a rapid survey of river populations it is possible that a single count or a series of counts will give an accurate population figure and even an accurate nesting population without recourse to locating nests. The fact that the direct count closely approached the number of paired geese determined from location of nest sites indicated that the river population comprised few unpaired birds and that the total of 88 pairs of nesting geese located during a period of one month on the 40-mile stretch of the Snake River was close to the total nesting population.

Observations indicated that this same density (an average of 2.2 pairs per mile) of nesting geese extended up the Snake River into Yellowstone Park as well as down the river for an undetermined distance. The larger tributary streams in the Jackson Hole area likewise served as breeding areas but with a somewhat lower nesting density.

GOSLING COUNTS

Through May 21, 82 young were known to have hatched with some eggs still being incubated. Through July 11, the count was 21 separate broods totalling 94 goslings. The broods varied from one to seven with an average of 4.5 goslings. At that time the immatures could still be distinguished from adults by the duskier white cheek patch (adults had a much more brilliant and sharply outlined patch) and by their general

duskier and more brownish cast. On July 20 another float trip was made and the goslings counted. By this date they could fly, were consequently more difficult to approach and could not always be distinguished from adults. Some geese were still in family groups but the majority were in flocks, the largest of which was 40. Thirty-three goslings were counted in family groups and 105 geese in mixed flocks. Of these latter the authors calculated that on a basis of 4.5 goslings to a pair of adults, there were approximately 73 goslings represented in the mixed flocks. The attempted separation counts were in line with this figure. The total of 106 goslings was felt to more nearly approach the actual number of goslings on this stretch of river than any of the previous counts. Approximately 100 goslings reached the early flying stage (about six weeks).

PRODUCTIVITY

It would therefore seem that 88 pairs of nesting geese produced 106 goslings, or 1.2 goslings per pair, or less than one per adult. The largest clutch of eggs found was seven. Using this as the maximum potential of the species in this region, the potential productivity would be 616 goslings. On a basis of an average clutch of 5, the potential productivity would be 440. Both figures are considerably higher than the actual observed productivity of 106.

MORTALITY FACTORS

Some of the principal mortality factors which brought about this discrepancy between actual and potential productivity were flooding, predation, and unfavorable weather conditions combined with the first two factors. Observation indicated that these factors caused the greatest mortality prior to hatching. The survival of goslings appeared very high. Williams and Marshall (1938) likewise found that mortality factors in goslings were negligible.

SWIFT WATER

The authors suspected that high swift water might cause juvenile mortality by separating the goslings from their parents. Broods separated and dispersed by the rubber raft were watched and rechecked as to numbers. In such instances young geese followed the raft for several miles and on occasion actually appeared to mistake the raft for their parents. The goslings were too young to fly, yet could not swim against the swift current. There was, however, no indication that the swift water, although dispersing broods and altering territories, was a mortality factor in young geese. The adults usually rounded up their offspring and remained in the new downstream territory. It is of interest that throughout the breeding season, intra-specific strife was singularly lacking. On numerous occasions geese grouped together in apparent defence of a raven-destroyed nest. When undisturbed, the family units stayed in the vicinity of their nesting sites for long periods. Many broods eventually mixed with other broods. There was a general tendency for families to drift gradually downstream and to congregate at wide island-studded expanses where the divided current was less swift.

BIRD PREDATORS

On each trip, hawk and eagle nests or

nesting territories within one-fourth mile of either river bank were located and plotted on a map. Territories consisted of an area where these birds exhibited nesting behavior, indicating a nearby nest. A total of 36 nesting pairs was found: 13 red-tailed hawks, 18 sparrow hawks, 0 Swainson's hawks, 8 sharp-shinned hawks, 4 Cooper's hawks, 1 bald eagle. This was not the complete nesting bird-predator population along this stretch of river. The population surveyed in this manner was approximately 1 pair per mile of river or nearly 2 pairs per square mile of nesting area, and did not include owls. Much more intensive studies on predator populations in this region (unpublished) indicated a hawk nesting population of 2.75 pairs to the square mile. The hawk population, however, had no observed effect on the mortality of goose broods. The most likely bird-predator was the bald eagle. Eight goose nests were located within a distance of one-half mile of this eyrie, yet no gosling remains were found at the nest and the geese apparently did not fear the eagles. Mortality from ravens was a different story.

Raven nests and broods along the river were plotted on each trip. Eighteen nests or broods were located. They were fairly evenly distributed and sufficiently near the river that both adults and young ravens could hunt the river flats. Ravens were observed ranging several miles from their nests so that 18 pairs could forage very efficiently over the entire 40-mile stretch of river. Early in the study it became evident that ravens were a factor in the destruction of goose eggs. None was actually caught in the act of destroying eggs, but there was sufficient indirect evidence to incriminate them. The following description of a raven-destroyed nest was more or less typical of all so classed: the nest down was scattered, egg shell remnants were strewn with the down to a distance of 10 or 15 feet. Shell fragments were found on and beneath a nearby perch five feet above the ground with raven excrement beneath. Such a perch could not have been used by any terrestrial predator. The usual bloody membranes of hatched eggs were lacking. Adult ravens were seen nearby. This picture, with slight modifications, was similar at all nests where ravens were suspected of the destruction. Ravens frequently flew low over the wide areas where geese congregated to nest. In such places they foraged, combing back and forth over the channels and island bars. On other occasions, when geese were honking, the noise soon brought ravens to the spot. Usually they flew past while looking the situation over but quite possibly they returned later, perhaps in a manner similar to the following observation:

Soon after sunrise two geese were heard honking noisily about one-fourth mile from the observer, who was hidden in a spruce stand. In a few minutes they passed overhead on their way to feeding grounds. Two ravens then immediately left the woods, flew in the direction from which the geese had come, and quartered the nesting area, flying very low.

This particular goose nest had already been destroyed by ravens and the geese had started a renesting attempt. These geese had been previously observed flying off together leaving the nest hid-

den but unattended; and they usually honked noisily as they took off. The authors feel that their noisy behavior at the nest and their habit of leaving it unattended were the principal causes leading to destruction by ravens. It appeared that the egg-laying period prior to incubation was the time when a nest was most likely to be left unattended. Thirteen nests gave evidence of having been destroyed by ravens. Coyote tracks were seen in the vicinity of two of the destroyed nests but there was not sufficient evidence to attribute their destruction to these mammals. Sooter (1946) says that "the coyote proved to be a major predator on the Refuge [Malheur National Wildlife Refuge] being equalled only by the raven." Coyotes were not numerous along the Snake River. None was seen but a few were heard in the course of raft trips. An area of 12 square miles (3×4 mi.) embracing both sides of the river at Moose had 2 denning pairs, the dens being located on opposite extremities of this area.

FLOODING

By May 21, 9 nests were known to have been destroyed by flooding. This early flood condition was caused by increased tributary flow as a result of melting snow. On May 3, with the Moran river gauge reading 1.23, the water level at Moose had risen 2 feet 0 inches and by May 11 to 5 feet 2 inches above the low water mark. On May 22 the discharge of water from Jackson Lake was 3.71 feet and on May 25, when Jackson Lake filled, the natural flow was allowed to spill out. Not until this time had water from the dam played a role in flooding of nests. This release, however, raised the water level at Moran from 1.03 feet, or low water, to 6.84 feet, and the level at Moose to 5 feet above the low water mark.

Below Moose still other tributaries, the largest of which is the Gros Ventre, poured additional flood water into the Snake, thus increasing flood conditions in the lower part of the river. The authors estimated that nearly all the goose eggs would have hatched by June 1. This high water during the last week of nesting, however, accounted for an appreciable but unmeasurable destruction. On May 28 the water levels at Moran and Moose were approximately 8 feet and 5 feet 8 inches, respectively, above the low water level. As mentioned before, the average height of goose nests above low water mark was 3 feet. The flooding of nests, however, was not so great as these figures would indicate because the geese had selected the wide channel-cut stretches of river bottom where flood waters were dispersed so successfully that the actual rise of water in some channels was considerably less than at the measurement stations.

Information on nest successes and failures was as follows:

Successful nests	21
Destroyed by ravens	13
Destroyed by flooding	9
Unknown destruction	45

Most of the nests falling under "unknown destruction" could probably be attributed to flooding and ravens, with perhaps a few to coyotes, a few to nest site competition (unobserved), and others to indifference, infertility, and other characteristics of the geese themselves. Nests assumed to be destroyed by ravens were easier to locate than those that had been flooded out, and

this fact is somewhat responsible for the higher mortality figure. It is also quite possible that some nests destroyed by ravens had been abandoned before destruction. After the highest water there was no way to determine how many nests still with eggs were destroyed and at how many of them the at a corresponding date. Considerably fewer goslings were seen in 1946 along the entire stretch of river studied. Table 1, showing comparative water release levels at Moran for the two years in conjunction with the nesting activity of geese, points to a possible reason for low gosling productivity in 1946. These

TABLE 1.—GOOSE ACTIVITY DATES AND ACCOMPANYING WATER LEVELS FOR 1946–47 ON THE UPPER SNAKE RIVER, WYOMING

Goose Nesting Activity—1947	1946 Water Levels at Moran	Comments	1947 Water Levels at Moran	Comments
Month prior to nest selection (March)	Max. 5.00 Min. 3.66			
Earliest nest site selection March 25–April 1	Av. 5.12	Sites probably selected on high ground	Min. Flow 1.05 April 1	Sites selected on low gravel bars
Ht. of nest site selection (April 10–18)	Av. .97	Majority of nest sites probably selected on low ground	Min. flow to May 1	Sites selected on low gravel bars
1st egg laying (April 1)	5.08	Few in numbers		
Period of maximum egg laying (April 18–23)	Av. .87	Egg laying successful		Nesting activities unaffected by water flow
Incubation and continued egg laying (April 23) Approximate 5' rise in water	5.45	Flood mortality possibly very high at end of maximum egg laying period		
First hatching (May 6)	.43	Minimum flow		1st hatching successfully completed
Peak of hatching (May 16–21)	Av. .41	Minimum flow No flood damage		Peak of hatching successfully passed
May 23			8.84	Lake filled, natural flow, destruction of some nests still containing eggs. First discharge May 21 of 3.71'
May 28 some incubation	4.00		9.21	
May 29 some incubation	7.70	Lake filled, natural flow	8.30	
Nesting completed (June 1)	6.03		8.26	Nesting completed
Goslings on river (June 10)	8.25		9.28	Little or no gosling mortality due to high water

eggs had hatched prior to high water. The authors estimate that perhaps 25 per cent were destroyed by flooding. However, flooding as a mortality factor can be much greater than the authors found in the spring of 1947. For example, in 1946 only 12 goslings were counted along a 25-mile stretch of the river, whereas in 1947, 33 were counted water level figures also indicate the nest destruction that could result from a water control policy inconsiderate of the vulnerable periods in the nesting cycle of Canada geese.

In 1947 the period of nest site selection ranged between the last week of March and the last of April. The peak of nest site selection occurred during a

short period prior to the height of egg laying and in most instances could not have occurred earlier since the sites were covered by 2 to 3 feet of snow. The peak of laying was between April 18 and 23. Site selection was at a maximum during the preceding week to ten days (April 10-18). The earliest nesting of a few birds was on April 1-3 and those geese were in the lower stretch of the river. The difference in altitude between these lower nests and the uppermost one was as much as 500 feet. Milder weather and less snowfall was typical of the lower region. If the water levels for 1940 (Table 1) are checked with these 1947 dates, it is seen that during March the maximum and minimum river heights were 5.90 feet and 3.00 feet, respectively. On April 1, the river height rose to 5.08 feet and dropped to a more or less minimum flow thereafter until April 23. One day of high water, 4.83 feet, intervened on April 9. The few earliest nesters, influenced by the relatively high March flow, probably nested in high places where snow-free sites were available. However, the period between April 1 and 23 was one of low water save for one day. This period embraced not only that of maximum nest site selection but also of maximum egg laying. It is reasonable to assume that many sites were selected low and close to water. A drop in water level from April 2 to April 23 would have bared gravel bars previously covered by water. These low bare gravel bars would be attractive as nest sites in comparison to the surrounding environment of deep snow. This period of low-water, site-selection, and egg-laying was followed on April 23 by a single flow of 5.45 feet. Figures on the location of nests in 1947 indicated a tendency for geese to nest both low and close to the water. Assuming that the average height of nests above the low water mark was 3 feet (as found in 1947) it is possible that with normal tributary contribution as well, close to 50 per cent of the nests could have been flooded out. In addition, if weather conditions such as an early or prolonged thaw accompanied this man-controlled rise in water, the actual flood conditions could have been even greater. This was actually the case in 1940 and the authors feel that the low goose productivity of that year resulted from the flood conditions and fluctuations of the Snake River during the nesting period.

In 1947 the natural runoff from thawing snows and spring storms accounted for flood loss in nests as late as May 22. Thereafter the discharge of water from Jackson Lake Dam flooded any nests that were still in the incubation stage. Fortunately the peak of hatching had passed. A week later, the same water rise (1.03 feet to 0.84 feet) would have done no harm.

The authors do not wish to imply that Jackson Lake Dam and the accompanying control of its water reservoir have increased nesting flood mortality of geese over that which existed prior to the dam. They do, however, want to point out that the dam has made possible a control of flood waters previously not manageable. Water could be discharged from Jackson Lake so as to cause practically no flood loss; on the other hand, it could be released in such a manner that it would destroy an estimated 80 to 90 per cent of the goose nests.

MANAGEMENT SUGGESTIONS

Two practices which can do most to maintain a nesting goose population and increase its productivity in this area are:

1. The continued preservation of nesting and feeding grounds.

2. The encouragement of a policy that as far as is practical attempts to regulate water levels beneficially during the breeding season of Canada geese.

The first will in large part be taken care of automatically if the Jackson Hole National Monument remains intact as created by President Roosevelt or if this land remains under government control. Fifty of the 88 pairs of geese nesting along the 40 mile stretch of river were within the Jackson Hole National Monument. Numerous lakes in the Monument offer havens of safety as well as feeding areas for both resident and migrating geese. This is particularly true of the northern end of Jackson Lake.

As to the second factor, the present water regulation policy governing the flow through Jackson Lake Dam considers: first, the water users; second, flood control.

The Bureau of Reclamation in its multiple tasks of conserving water, protecting dams and reservoirs from floods, and distributing water as required by project interests is not unmindful of wildlife demands. At times it is necessarily working with many variable and uncontrollable factors. In view of the importance of this area to nesting Canada geese, heretofore unsuspected, it is hoped that the Bureau can fit the needs of the Canada geese into its multiple water control plans.

Once the dam fills, all water control is automatically lost. Severe property damage has resulted in the past from a lack of control during high tributary runoff. In early years this was unavoidable; however, the surveys of snow depth made over the years by the Bureau of Reclamation show that it is now possible to determine the amount of runoff and to forecast, with an accuracy of 80 per cent, the volume of water to flow into the dam. Since 1917, the reservoir has filled to capacity in 19 of 31 years. Better winter and spring water control could help the goose situation without jeopardizing the later filling of the dam. A safe margin of reserve is necessary in the event of an abnormal spring and too much water cannot be released until April 15 when the last snow survey is taken and final data are available for forecast. Within this limitation, it would appear beneficial to release a variable but predetermined amount of water from the dam during the winter months to prevent early filling of the lake. High water during March and the first half of April could then be followed by a low and non-fluctuating water flow until the first of June. This was nearly achieved in 1947. Such control would react favorably toward nesting geese in two ways: it would cause them to initiate nest construction at a generally higher level, thus providing a larger margin of safety in case of a rise in the water due to tributary flooding, and it would delay the filling of Jackson Lake Dam until the completion of hatching.

Such control would not cause stress to Idaho farmers, particularly in view of the fact that the lower Palisade Dam and Reservoir below Alpine will, when completed, ease the demand on the

Jackson Lake Reservoir. Perhaps the best way of attaining this control would be to take approximately 400,000 acre feet of firm storage space in Jackson Lake and transfer it to Palisade Reservoir. This would make available space in Jackson Lake Reservoir for flood control. It would help remedy spring flood conditions of the Snake River in and below Jackson Hole and would go far toward putting a stop to contemplated plans of dyking and channelling this picturesque river in the lower part of the region studied. Over a period of years water control cognizant of wildlife needs as well as the needs of irrigation and flood control might well double the present Canada Goose productivity in this area.

SUMMARY

Geese in the Jackson Hole area during 1947 started nesting on or about April 1 with the peak of laying and hatching between April 18-23, and May 16-21, respectively. Nesting was completed by June 1.

Nests were distributed over a 40-mile stretch of the Snake River averaging about 2 per mile with marked concentrations in the wide channel-split expanses of river bottom.

Ninety-five per cent of the nests were located on islands and most sites were elevated piles of drift or sod situated on or beside gravel bars.

Of 43 nests above the low water mark, the average height was 34.5 inches, the maximum 76 inches, and the minimum 0 inches.

The average distance of 43 nests from water was 43 feet, the maximum 150 feet, and the minimum 1 foot.

The average clutch determined from only 17 nests was 4.6 eggs per nest; 5 was thought to be a more representative figure.

Eighty-eight pairs of geese either nesting or exhibiting territorial behavior were located, and this was considered very close to the actual nesting population.

Counts during two float trips down the Snake River indicated between 90 and 94 pairs of geese.

The similarity in results of the two methods indicated that along a river a direct count of paired geese exhibiting nesting behavior will give a rapid and accurate picture of a potential nesting population without recourse to the more time-consuming task of locating nests. It was felt that there were few unpaired geese among the population.

The density of 2.2 pairs of nesting geese per mile of river studied appeared to extend both up and down the Snake River for considerable distances and to apply to the larger tributary streams as well.

A count on 21 separate broods gave an average of 4.5 goslings per brood.

One hundred and six goslings were known to have reached the flying stage (about six weeks). This amounted to a productivity of 1.2 goslings per pair on the basis of 88 pairs.

Mortality factors were most active before and during incubation. Little or no gosling mortality was found; 21 nests were known to have been successful, 13 were destroyed by ravens, 9 were definitely flooded, and 45 were classified as destroyed by unknown causes but most of the loss was believed to have been due to flooding and to raven predation.

Twenty-five per cent of the nests

were estimated to have been destroyed by flooding. Flooding has and could cause much greater losses. Flood mortality can to a large extent be eliminated by water control.

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